PORTULACA PILOSA L., *P. MUNDULA* I. M. JOHNST. AND *P. PARVULA* GRAY IN THE SOUTHWEST

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ABSTRACT

Historically the taxonomic interpretation of three species of *Portulaca*—*P. pilosa* L., *P. mundula* I.M. Johnst., *P. parvula* Gray has been unsettled. The basis for each interpretation has been reevaluated using material representing collections from both the Southeast and the Southwest United States. Morphological characters traditionally used in descriptions and keys, along with an examination of the seed surfaces by scanning electron microscopy, have provided evidence that *P. mundula* is conspecific with *P. pilosa*. The interpretation of *P. parvula* is still uncertain due to lack of study material. Theoretical patterns of the migration of *Portulaca* are presented.

TAXONOMIC HISTORY

In 1753 Linnaeus described *Portulaca pilosa* as having alternate, subulate leaves, with axillary hairs and sessile flowers. He did not mention flower color, but cited publications by Herman and Commelin as treating the same red-purple flowered species.

In 1887 Asa Gray published the name *Portulaca parvula*, describing the species as having yellow to copper-colored petals. He noted that *P. parvula* in Texas, New Mexico and Mexico was part of several specimens labeled *P. pilosa* which were collected by Wright, Fendler, Schaffer *(772)* and Pringle *(543)*. From Gray's comments it is apparent that he was treating mixed collections and segregating the yellow-flowered taxon from the red-flowered *P. pilosa*. He gave the distribution of *P. pilosa* as Florida to Arizona.

Gray's Manual of Botany, ed. 7 (Robinson and Fernald, 1908) recognized *P. pilosa* as the red-flowered taxon in the Southwest, with no mention of a yellow-flowered taxon. Ivan M. Johnston (1948) examined the mixed specimens that Gray had cited. In his judgment, the red-flowered specimens constituted a new species, *P. mundula* I.M. Johnst. Johnston commented that an examination of illustrations and comments from Commelin (1697) and Herman (1705) left little doubt as to the Linnean concept of *P. pilosa*. Hence, in his opinion the red-flowered specimens were not *P. pilosa*.

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Gray's manual, ed. 8 (Fernald, 1950) recognized *P. parvula* as the only southwestern species, including in the description both red and yellow flowers, and noting that the treatment in ed. 7 was not *P. pilosa* of Linnaeus.

Shinners (1958) treated *P. mundula* as a synonym of *P. pilosa* and commented that the yellow-flowered species, *P. parvula,* occurred to the west and south of the Dallas-Fort Worth area. Legrand (1962) in his monograph of the American species of *Portulaca* treated *P. mundula* as a variety of *P. pilosa.* He noted that var. *mundula* differed from the typical variety by a reduction in size of all its organs. The distribution of var. *mundula* is given by Legrand as from the tropics to northern Mexico (Chihuahua and Coahuila), the southwest United States into Colorado, Texas, Oklahoma, Kansas and Missouri. Legrand commented that there was clearly a transition of morphological traits from var. *pilosa* to var. *mundula* from the tropics to the northern arid habitats. Legrand treated the yellow-flowered *P. parvula* as part of *P. halimoides* L. He stated that *P. parvula* Gray sensu Johnston represented the depauperate form of *P. halimoides* resulting from the adaptation to desert regions. Correll and Johnston (1970) modified their treatment of *Portulaca* from Legrand but recognized *P. mundula* and *P. parvula* as species, without recognizing *P. pilosa.*

A NEW EXAMINATION

In the course of preparing the treatment of *Portulaca* for the Vascular Flora of the Southeastern United States it was necessary to decide whose treatment was the most accurate. Additionally, since the Southeast extends into Arkansas and Louisiana, it became necessary to examine specimens from herbaria in the Southwest. *Portulaca mundula* is reported from Arkansas and some specimens from Louisiana have been identified as *P. mundula.* Several problems emerged: 1. Does *P. pilosa* occur in the southwest? 2. Can *P. mundula* de differentiated from *P. pilosa?* 3. What does the name *P. parvula* represent?

To address these problems over 1,800 specimens were borrowed from the following herbaria: ALU, ASTC, DUR, FLAS, FSU, G, GA, JSU, KNK, KY, LAF, LL, MO, NCU, NLU, NO, NY, SMS, SMU, TENN, TEX, UARK, UNA, UNCC, US, USAM, USCH, USF, VDB, VPI, VSC, WILLI.

Examination of the specimens both for distribution and morphological variability indicated problems in separating *P. mundula* from *P. pilosa.* Since no taxonomic treatments have compared all three taxa, including *P. parvula,* with analyses of the distinguishing character states separating them, an attempt was made to do so, using the characters provided by I.M.

Johnston, Legrand, and Correll and Johnston. Comparison of all of the morphological traits used to define the species showed that the characters of capsule diameter, capsule pedicel length, seed diameter, color and surface texture, and flower color seemed to provide the clearest traits for identification. These literature data are shown in Table 1.

Additionally the Southeastern treatments have been limited to state boundaries without consideration of variation throughout the range. Specimens were examined by state, beginning in Florida because *P. pilosa* is the original taxon to which to compare any later segregates. *Portulaca pilosa* has been unchallenged as the Florida taxon in treatments by Small (1933), Legrand (1962), Long and Lakela (1971) and Wunderlin (1982). Legrand,

TABLE 1. Key morphological features for the three taxa, taken from the literature. Multiple entries are character states given by I.M. Johnston, Legrand, and Correll and Johnston respectively. Lack of a statement is shown by ----.

	P. PILOSA	P. MUNDULA	P. PARVULA
Capsule diameter in mm	----	2.5-3.5	1.5-2.0
	2.5-4.3	2.0-3.0	----
	----	2.5-3.5	1.5-2.0
Pedicel length in mm	----	Short stipitate	1.0-1.5
	Up to 1.0	Up to 1.0	----
	----	Lightly stipitate	1.0-1.5
Seed diameter in mm	----	0.3-0.5	0.3-0.5
	0.5-0.65	0.5-0.6	----
	----	0.3-0.5	0.5
Seed color	----	Black	Black
	Black	Black	----
	----	Black	Black
Seed surface	----	Stellate-tuberculate	Stellate flattened roughenings
	Small tubercles dorsally, stellate on sides	Stellate-tuberculate	----
	----	Stellate-tuberculate	Stellate flattened roughenings
Flower color	----	Purple	Yel-orange, bronze
	Purple	Purple	----
	----	Red-purple	Yel-orange, bronze

being very familiar with the Central and South American taxa, cited specimens which he considered as *P. pilosa* from Florida. We have accepted Legrand's conclusion that *P. pilosa* is the correct name for the Florida taxon.

Specimens were selected from counties throughout Florida to provide a basis of variability for *P. pilosa*. Observations of the same character states, as shown in Table 1, were made. If two specimens from the same county appeared morphologically dissimilar, both were included. Thirty eight specimens were measured or scored, with three observations on each specimen, for the traits of capsule diameter, capsule pedicel length and seed surface features. Following this, the same observations were made on all specimens from Alabama ($n = 6$), Mississippi ($n = 16$), Louisiana ($n = 57$). Specimens that could not be positively identified as having red flowers were excluded. Since Texas represents a large diversity of regions and habitats, capsule and pedicel measurements were grouped according to distributions in the coastal plain (CP), in the high prairie (HP) and in the Trans-Pecos (TP). Additionally, 23 specimens from Missouri, Oklahoma and Texas, cited by Johnston in his original description of *P. mundula* were measured and compared. These paratypes, as well as the populations and subpopulations defined above are compared in Table 2.

The ANOVA (Table 2) for pedicel length for the seven states, with Texas segregated into three subpopulations, including Jonnston's paratypes show no significant differences between any two populations (unplanned comparisons using the Tukey-Kramer procedure, Sokal and Rohlf, 1981). Some interesting relationships are evident. The specimens from the high prairie (HP) of Texas are separate from the other Texas subpopulations. The other Texas subpopulations (CP & TP) are grouped with the Florida population while Johnston's paratypes are intermediate.

For the capsule comparisons, using the same geographical grouping, an ANOVA (Table 2) with unplanned comparisons using the Tukey-Kramer procedure shows the following: Capsule diameters of plants from Arkansas, Oklahoma and Johnston's paratypes are significantly smaller ($p < .05$) than the capsule diameters of plants from Texas, Mississippi, Florida and Alabama. Plants from Louisiana are intermediate between the two groups. However none of the Texas subpopulations are significantly different from those of Florida.

Since there is no significant difference among the nine geographical populations and the paratypes in the pedicel comparisons, and since the two groups in the capsule comparisons are of mixed geographical arrangement, the variability of the taxonomic characters traditionally used cannot be predictably segregated to represent two taxa. A comparison of capsules vs pedicels shows a strong positive correlation ($r = 0.310$, $df = 174$, $p < .01$);

TABLE 2. Comparison of pedicel lengths and capsule diameters for Alabama (AL), Arkansas (AR), Florida (FL), Louisiana (LA), Mississippi (MS), Oklahoma (OK), Texas coastal plain (TX-CP), Texas high prairie (TX-HP), Texas Trans-Pecos (TX-TP) and Johnston's Paratypes (JP). Means connected by lines are not significantly different at the .05 level.

PEDICELS

Pop.:	AR	TX-HP	LA	MS	OK	JP	FL	TX-TP	TX-CP	AL
Mean	0.363	0.429	0.441	0.453	0.500	0.539	0.595	0.605	0.613	0.617
SE	0.077	0.053	0.053	0.056	0.053	0.046	0.035	0.050	0.055	0.089
N	8	17	17	15	17	23	38	19	16	6

CAPSULES

Pop.:	AR	OK	JP	LA	TX-HP	TX-TP	MS	FL	AL	TX-CP
Mean	1.875	1.924	1.965	2.212	2.335	2.426	2.447	2.518	2.600	2.619
SE	0.112	0.077	0.066	0.077	0.077	0.073	0.082	0.052	0.130	0.080
N	8	17	23	17	17	19	15	38	6	16

but these characters do not vary together.

Comparison of the averages shown in Table 2 with the ranges listed in Table 1 show that the southeastern United States specimens (Florida, Alabama, Mississippi, Louisiana) fall at the lower range for capsule diameter and pedicel length as given by Legrand for *P. pilosa* throughout its range. This is not surprising since most of Legrand's measurements were made on more tropical, hence more robust specimens. His studies centered on Central and South American specimens and *Portulaca* is primarily a genus of these areas. He did however examine specimens from Florida, Georgia and Mississippi to develop his concept of *P. pilosa* for the United States.

Seed surface texture, Table 1, has been used as a character for species separation. In fact, many specimens lacking petals have been identified using the seed surface texture character. Representatives of the seed surface patterns for known red-flowered specimens from seven states are grouped to illustrate the variability over the entire geographic range, Figs. 1 – 22. Original labels were either *P. pilosa*, *P. mundula*, or *P. parvula*. The bar on each figure represents 100 μm. Seeds were sputter coated with gold-palladium on a Hummer V and viewed on a Jeol JSM-35CF SEM. Specimen citations from which seeds were taken are shown elsewhere.

FLORIDA—Thirty eight specimens had stellate-tuberculate surfaces; the tubercles varied from very short to medium, none were flattened (Figs. 1 – 3).

ALABAMA—Six specimens had stellate-tuberculate surfaces; the tubercles varied from very short to short (Fig. 4).

Mississippi—Nine specimens had stellate-tuberculate surfaces; five had stellate flattened roughenings and two had seeds in which some were tuberculate and some were flattened (Fig. 5).

Louisiana—Twelve specimens had stellate-tuberculate surfaces (Fig. 6), five had stellate flattened roughenings (Fig. 7). At this location in the geography, the variability of stellate flattened roughenings in northern Louisiana is evident.

Arkansas—All 20 specimens had stellate flattened roughenings (Fig. 8). This pattern complements that of northern Louisiana.

Texas—Twenty eight specimens scattered over the state had stellate-tuberculate surfaces, 23 had stellate flattened roughenings. Texas specimens exhibited the greatest range of diversity. Figures 9 – 12 present the coastal plain variability. Figure 17 shows the same stellate-tuberculate pattern farther inland. Figures 18 – 21 present the range of variability in the Trans-Pecos region, from stellate flattened to highly stellate-tuberculate.

Oklahoma—Figures 13 – 16 & 22 show the same pattern found in the high prairie of Texas with none to only slight impressions of the stellate-tuberculate pattern. Figure 22 illustrates the extreme flattening in the western populations.

To obtain an overall perspective of variability in seed surface texture over the western geographical area, a three × five inch scale map of Louisiana,

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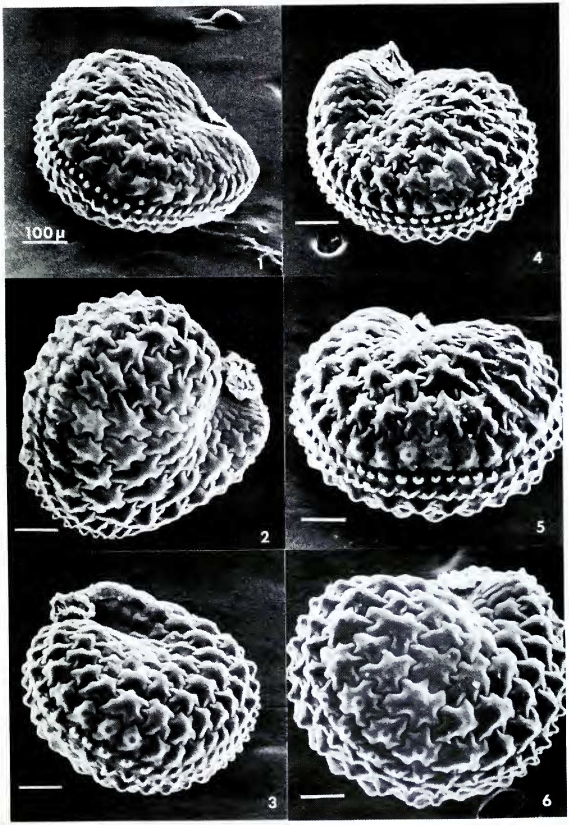
Figures 1 – 24. Scanning electron micrographs of seeds of red-flowered portulacas, originally labeled *Portulaca pilosa*, *P. mundula* or *P. parvula*. 1. Florida. Dade Co.: 1 Aug 1940, *Arnold s.n.* (FLAS). 2. Florida. Citrus Co.: 13 Aug 1958, *Kral 7825* (NY). 3. Florida. Escambia Co.: 8 Aug 1981, *Burkhalter 7859* (FSU). 4. Alabama. Mobile Co.: 20 Aug 1968, *Kral 32710* (GA). 5. Mississippi. Harrison Co.: 6 Jul 1952, *Demaree 32138* (SMU). 6. Louisiana. Allen Co.: 23 Oct 1964, *Thieret 18690* (FSU). 7. Louisiana. Morehouse Co.: 27 Jul 1977, *Thomas & Pias 54274* (NLU). 8. Arkansas. White Co.: 14 Oct 1974, *Demaree 64262* (GA). 9. Texas. Hardin Co.: 27 Aug 1970, *Ammerson & Watson 244* (SMU). 10. Texas. Refugio Co.: 13 Oct 1956, *Shinners 25232* (SMU). 11. Texas. Cameron Co.: 22 May 1959, *Traverse 1046* (G). 12. Texas. Austin Co.: 12 Oct 1971, *Thomas 26208* (NLU). 13. Oklahoma. Bryan Co.: 30 Sep 1974 *Turner 39* (DUR). 14. Oklahoma. Oklahoma Co.: 7 Jul 1976, *Taylor 28950* (NLU). 15. Oklahoma. Harmon Co.: 26 Aug 1948, *Waterfall 8716* (G). 16. Oklahoma. Woods Co.: 5 Oct 1913, *Stevens 2882* (MO). 17. Texas. Frio Co.: 24 Jul 1941, *Tharp s.n.* (SMU). 18. Texas. Brewster Co.: 18 Jul 1936, *Warnock 121* (SMU). 19. Texas. Brewster Co.: 23 Aug 1970, *Semple 408* (MO). 20. Texas. Culberson Co.: 21 Jul 1943, *Waterfall 5242* (G). 21. Texas. Ward Co.: 18 Sep 1966, *Correll 33652* (NCU). 22. Oklahoma. Cimarron Co.: 11 Aug 1977, *Taylor 25255* (NLU). 23. Oklahoma. Indian Terr.: 21 Sep 1894, *Bush 31* (MO). 24. Mexico. Coahuila: 24-26 Aug 1938, *Johnston 7088* (G).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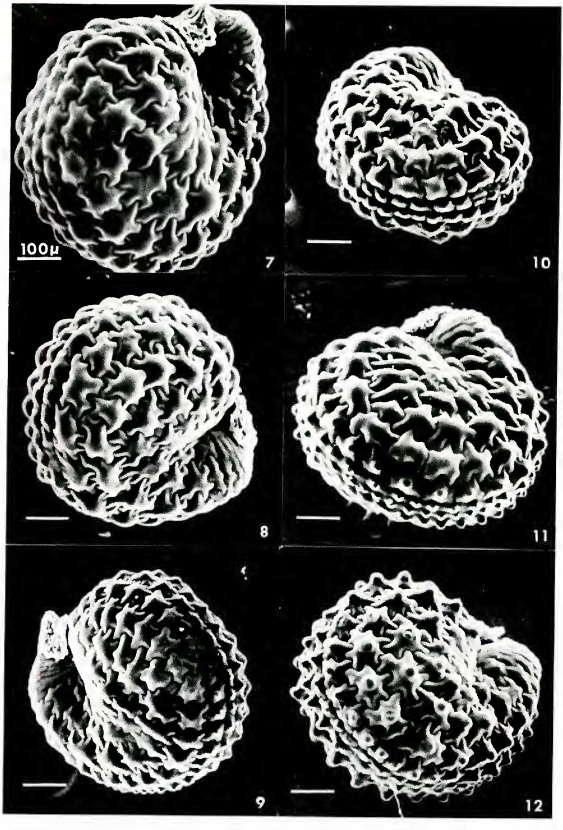
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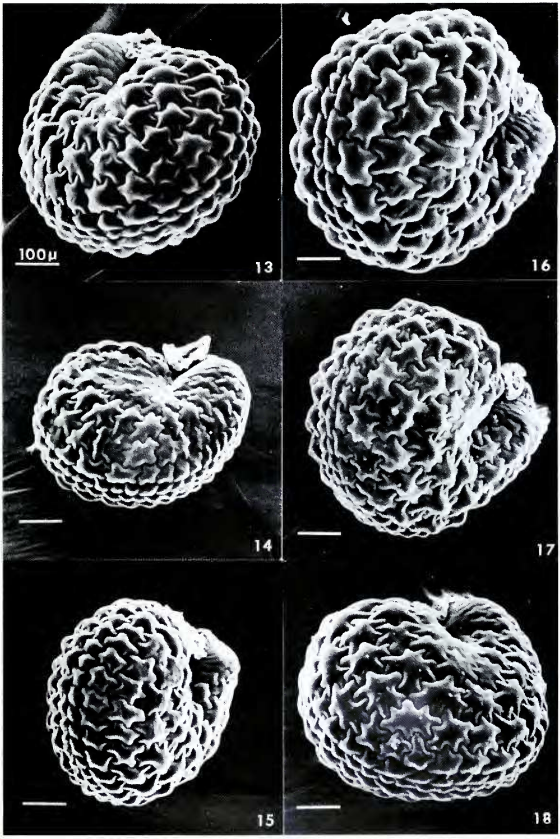
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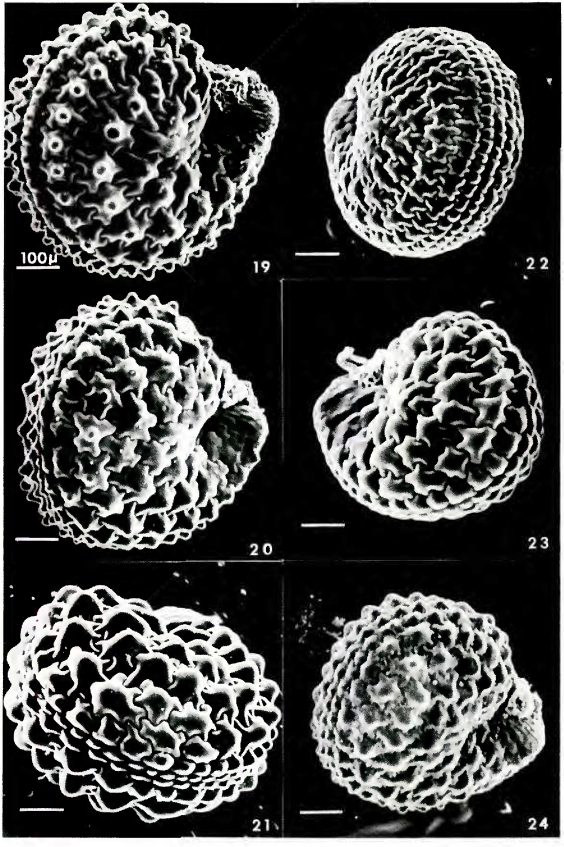
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Arkansas, Missouri, Oklahoma and Texas was covered with clear, double-sided tape and individual seeds were placed on the map in the locations of their collections. Examination under a 30× stereoscopic microscope made possible an analysis of local and broad patterns of variability. The maximum diversity of seed surface texture was noted in the Trans-Pecos (Figs. 17 – 21). There was an overall trend of flattened roughenings and less tubercles toward the north and west. To see this, compare Figs. 6 – 8 from Louisiana and Arkansas, Figs. 9 – 12 from south and central Texas with Figs. 12 – 16 from central Oklahoma and Figs. 17 – 21 from the Trans-Pecos with Fig. 22 from Western Oklahoma.

From an analysis of these surface patterns (Figs. 1 – 22) it is apparent that variability of seed surface patterns occurs within geographic regions and within the species. Since all these seeds were taken from known red-flowered plants, seed surface texture is not a trait which alone can be used to separate red-flowered *P. mundula* from *P. pilosa*. Legrand stated that seed surface texture was not a good character for distinguishing varieties of *P. oleracea,* so the implication is that it is not a good character for distinguishing species, which our data support.

THE CONCEPT OF *PORTULACA MUNDULA*

The character states taken from descriptions and keys, listed inTable 1 show very little difference between the taxa called *P. pilosa* and *P. mundula*. When Johnston formulated the idea of *P. mundula* he stated that he had taken his concept of *P. pilosa* from pictures portraying the Linnean taxon, but there is no indication that he examined any specimens of *P. pilosa* outside of the Southwest. It would be difficult, in our opinion, to develop a concept of variability of as widespread a taxon as *P. pilosa* from pictures, particularly those as stylized as Commelin's and Herman's. Examination of their descriptions shows only one inconsistency in the typical morphological expression of *P. pilosa;* this being in the leaf morphology. Herman notes that the tops of the leaves are flat, Commelin makes no such reference. In our observations, the typical terete leaf cross-section may become hemispherical (flat on top) in robust plants growing in richer soils. The overall shape, whether terete or hemispherical, is linear and not spatulate or oblanceolate.

The general lack of consistency in character states for the specimens from Texas made us wonder about the consistency of the material cited by Johnston. The holotype from Coahuila, Mexico, was measured or scored for the same characters; capsule diameter, pedicel length and seed surface, using 15 capsules from the type instead of three. The pedicel length

averaged 0.65 mm, with a range of 0.3 – 1.1, and the capsule diameter averaged 1.95 mm, with a range of 1.6 – 2.4. Note the ranges are from a single plant. These results also show a smaller set of averages than the ranges given by Johnston in his original description (Table 1). Of the paratypes which were compared in Table 2, only one specimen, Texas, Mill Creek, Aug 1843, *Lindheimer s.n.*, (G) had capsules 2.5 mm in diameter. For the seeds of the paratypes, 11 had seed surfaces that were stellate flattened roughenings, not stellate-tuberculate. These 11 specimens were from west Texas, Oklahoma and Missouri, while the stellate tuberculate seed surfaces were found on specimens from the remainder of Texas. Johnston cited no specimens form Arkansas. Figure 24 is a seed from the holotype, while Fig. 23 is a paratype from Oklahoma, (Indian Territory): Sapulpa, 21 Sep 1894, *Bush 31* (G). Note the close resemblance of Fig. 24, the type, to that of Fig. 3 from Florida, and that Fig. 23 does not fit the tuberculate pattern of the type. This tuberculate pattern has been used as a distinguishing morphological feature for the species. In fact, these findings on Johnston's paratypes show the same trends noted above, with flattened stellate roughenings toward the northern part of the distribution.

Portulaca pilosa has long been recognized as a taxon in Florida (Small, 1933). Legrand cited specimens from Florida, Georgia and Mississippi. Our measurements and analysis of capsule diameter, pedicel length, seed size and surface texture show no clearcut separation of red-flowered plants between Florida and Texas. Our data also support the comments of Legrand regarding the decreased size of capsules in plants growing in arid regions in contrast to larger capsules found in the tropics. The specimens with the smallest capsule diameters are from specimens recently collected from Arkansas, Oklahoma and Missouri. Some of the recent Texas specimens had small capsules, but the average of all Texas red-flowered specimens fits easily into the range of *P. pilosa*. It is possible to select specimens from dry habitats with small capsules and specimens from wet habitats with larger capsules. Unfortunately the habitat data on most of the labels are insufficient to permit an extensive analysis. Modern records from Arkansas, Missouri and Oklahoma show that the red-flowered species, which we are calling *P. pilosa*, is mostly restricted to dry ridges, bluffs and outcrops with sandy soil.

THE QUESTION OF *PORTULACA PARVULA*

Concerning the *P. pilosa*-*P. parvula* separation, as noted above, Gray treated the yellow-flowered taxon as *P. parvula*. Johnston redefined *P.*

parvula by adding the traits of small capsules, long pedicels and flattened stellate roughenings on the seed surfaces (Table 1). Measurements of the lectotype designated by Johnston: Mexico, Chihuahua: Sierra Santa Eulalia, fl. yellow 18 Aug 1885, *Pringle 543* (G), provided six capsules measuring 1.02 mm in diameter and pedicel lengths averaging 0.6 mm, both less than stated by Johnston, but the seed surfaces had stellate flattened roughenings. We have seen red-flowered specimens from Oklahoma with capsules 1.5 mm in diameter, pedicels 1.0 mm long and seeds with stellate flattened roughenings (Fig. 23). In examining over 700 specimens labeled *P. pilosa, P. mundula,* or *P. parvula,* only two were found with yellow flowers. This low number shows that either yellow-flowered, pilose Portulacas are rarely collected or they are less common than one would think. Taylor (R.J. Taylor, DUR 1984, pers. comm.) reported that yellow-flowered plants occasionally occur with red-flowered plants in Oklahoma. Smith (E.B. Smith, UARK 1984, pers. comm.) and Tucker (G. Tucker, APCR 1984, pers. comm.) have not seen yellow-flowered, pilose Portulacas in Arkansas. Steyermark (1963) does not report a yellow-flowered, pilose taxon in Missouri.

Legrand treated the yellow-flowered *P. parvula* under *P. halimoides* L. citing the depauperate growth in the deserts and reaching its northern limit in the United States. *Portulaca halimoides* is a Mexican species, occurring chiefly in the western half of that country which could be invading the Trans-Pecos through or around the Chihuahuan Desert. *Portulaca halimoides* may not have been known by Gray, hence his describing the yellow-flowered taxon as a new species. Johnston also may have been unfamiliar with it, and accepted Gray's interpretation. Before any final conclusions can be reached, further studies should be made of yellow-flowered species from a greater southwestern geographical range. Field studies to determine intermixing with red-flowered plants should also be undertaken.

There is another possibility for the occurrence of few yellow-flowered plants. More than one species of *Portulaca* has both red and yellow flowers. *Portulaca grandiflora* exhibits a wide range of petal colors and Legrand reports that *P. amilis* Speg. has a yellow-flowered form in South America, although in the United States so far only the red-flowered form has been seen (Judd and Wunderlin, 1981). There have not been any reports of *P. pilosa* having anything other than red flowers but it is possible that a genetic analysis of western populations may show an occasional yellow-flowered plant. This would account for the low incidence of yellow flowers overall or for the infrequent mention on herbarium labels of both red and yellow flowers in the same population as did Waterfall: Texas: Jeff Davis Co.: 20 mi SSE of Kent, 31 Jul 1943, *Waterfall 5415* (G).

THE PRESENT STATUS OF *P. PILOSA*, *P. MUNDULA* AND *P. PARVULA*

This study points up the problems of limiting the consideration of species concepts to unnatural boundaries and the importance of examining species complexes over a broad geographic range. Even in this case, the final answer will only come with a more extensive look at the Mexican flora.

In this study, comparison measurements of the character states of the morphological traits taken from descriptions and used in keys to distinguish *P. mundula* from *P. pilosa* show that there are no consistent characters which can be used, singly or together to separate the taxa. We conclude that *P. mundula* is conspecific with the more widespread and variable species *P. pilosa* and the name *P. mundula* should be treated as a synonym of *P. pilosa*.

For *P. parvula*, the only consistent identification trait is yellow petals. Specimens without petals cannot be identified by the seed surface texture as proposed by Johnston. However, without a more extensive examination of known yellow-flowered *P. parvula* along with a concept of *P. halimoides* we cannot reach any conclusion on the validity of *P. parvula* as a species.

CYTOLOGY

Very little information is known about the cytology of the genus *Portulaca* and there are some chromosome counts that are unusual. The cytoplasm stains darkly with aceto-carmine but fortunately the number of chromosomes is not large. The base numbers have been accepted as $\times = 4$ and 9, with polyploid multiples and possible aneuploid sequences.

The lowest number, $n = 4$ (Steiner, 1944), has a direct bearing on the *P. pilosa-P. mundula* problem. Steiner's report, unfortunately unvouchered, was taken from a plant collected at Springdale, Arkansas, in the NW corner near Oklahoma and Missouri. Steiner could not identify the plant to species and speculated that it may be a new species. The senior author has verified this count on plants grown from seed collected from a sandstone outcrop in Benton Co., Arkansas near Springdale. This species would now be interpreted as *P. pilosa*, and the specimen appears to be such. This count would represent a new number for this species, giving a sequence of $n = 4$, 8, 9, 18. The $n = 4$ is interesting in that it is the lowest number for the genus. The highest number for *P. pilosa*, $n = 18$, was reported by Hsu (1968).

Since *P. pilosa* is geographically widespread, the variation in chromosome number is not unexpected. However, it appears that *P. pilosa* exhibits polyploidy from both base numbers of the genus. How widespread the $n = 4$ number is for the high prairie of the United States and what relationship this number has to the actual numbers and to the potential for gene

exchange with the southwestern populations is unknown. Chromosome data need to be determined for the western populations. All counts for *P. pilosa* from the Southeast have been n = 8. A study of the cytology of this taxon in Oklahoma, Texas, Arkansas and Missouri would help to clarify the species concept in that area. If study shows that designation of a new species is warranted, then a new name would be needed, since the description associated with the name *P. mundula* probably would not encompass this new taxon. Also, the perpetuation of the name *P. mundula,* redefined to new limits, would only add to the confusion of the species concept.

THEORETICAL PATTERNS OF MIGRATION OF *PORTULACA* IN CENTRAL AMERICA AND THE UNITED STATES

Portulaca, with a large concentration of species in South America, has spread north into Central and North America, including the Caribbean (Legrand). *Portulaca pilosa* probably entered Florida from the Caribbean and spread northeast along the Atlantic coastal plain into North Carolina. A greater movement has taken place westward along the Gulf Coast, but there is no indication of an inland movement up the Mississippi embayment into Arkansas and Missouri. Only one isolated population, with measurements similar to those of the coastal plain has been reported from Tennessee, that along Interstate-40 (Wilson Co.). A scattered distribution is noted in northern Louisiana with most of these collections associated with recent human activity, e.g. railroads, road fills and dumps.

Northeast Texas shows the same scattered distribution as northern Louisiana, while the greatest concentration of *P. pilosa* is in south Texas along the Gulf Coast and in the Trans-Pecos region. There is a similarity of the plants in the Trans-Pecos area with those of the panhandles of Texas and Oklahoma, having a general reduction in size northeastward. Our label data show the distribution of *P. pilosa* in Arkansas in the mountains; the measurements show affinities with the gene pool of Oklahoma and not the coastal plain. The dates of collection also show a more recent movement eastward into Arkansas.The habitats in Arkansas are in the highlands and represent affinities with Oklahoma physiographically (G. Tucker, APCR 1984, pers. comm.).

Legrand commented on the existence of *P. pilosa* in the Caribbean Islands, Florida and Mexico, stating there was a morphological change toward smaller plants as one moves toward drier habitats, particularly in Mexico. These statements support the patterns of distribution indicated by the herbarium specimens we have seen. A two-directional pattern of movement of *P. pilosa* into the United States can be postulated: 1. From the Caribbean into Florida, northeast along the Atlantic coastal plain and also

westward along the Gulf Coast to the Mississippi embayment and, 2. From South America into Central America (Mexico) and northeastward into Texas, Oklahoma, Arkansas and Missouri.

A similar pattern can be postulated for the movement of *P. parvula,* if indeed it is really *P. halimoides. Portulaca halimoides,* according to Legrand, is found in central and western Mexico and "appears to be spreading along major highways." Its invasion into northern Mexico and southwest Texas (Trans-Pecos) is probably controlled to some extent by human activity and the availability of habitats as has been shown in other cases, particularly that of *P. amilis* (Judd and Wunderlin, 1981).

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